INTERVERTEBRAL LINKING DEVICE

The present invention relates to an intervertebral linking device.

Such a device is known which comprises at least two pedicular screws, each of which has a first end secured to a corresponding vertebral body, a bulging intermediate portion, and a second, threaded, end. Auxiliary members, provided with an arch for fastening a rod extending between the vertebrae, are located on each of the above-mentioned bulging portions. A bolt co-operating with the threaded end of each screw enables each auxiliary member to be immobilised, once that member has been put in place, in an appropriate manner.

However, this known device has some disadvantages in that it involves a relatively delicate mounting process. In addition, once implanted, it does not offer any degree of freedom between the various elements constituting it. Thus, when forces are exerted in the region of the vertebral bodies, the absence of a degree of freedom brings about a transmission of these forces onto the whole of the device, so that the device has a tendency to become separated from the vertebrae which it connects, and also brings about dysfunctions in the entire vertebral chain.

In order to overcome those various disadvantages, the present invention proposes to provide a device whose structure is simple, whose mounting is easy and which is reliably implanted in the vertebrae which it connects.

To that end, the invention relates to an intervertebral linking device which is to connect at least two vertebrae to one another, characterised in that it comprises:

- at least one fixed element which is to be secured to a vertebra or to the sacrum,

- at least one mobile linking element suitable for being displaced relative to the or each fixed element,

- and also at least one intermediate element permitting the articulation of the or each mobile element relative to the or each fixed element,

- in that the or each intermediate element is received, in use, in an internal volume of the mobile element, or of the fixed element, the intermediate element being deformable so that it can be introduced by impaction into that internal volume,

- and in that the fixed element, or the mobile element, is received at least partially, in use, in an internal volume of the intermediate element, the fixed element or the mobile element having, with the intermediate element, a mutual position of use in which the fixed element or the mobile element has three degrees of freedom in rotation, but is linked in translation, relative to the intermediate element, and a mutual position of introduction in which the fixed element, or the mobile element, has three degrees of freedom in rotation and in translation relative to the intermediate element.

According to other features of the invention:

- the intermediate element assumes the form of a cup;

- the internal volume of the intermediate cup is bordered by a truncated spherical surface;

- the intermediate cup has a truncated spherical external surface which is concentric with the internal surface;

- the internal and external surfaces define a wall of the intermediate cup;

- the thickness of the wall is from 0.5 to 3 mm, preferably from 1 to 1.5 mm;

- the intermediate element is produced from polyethylene.

The invention will be described hereinafter with reference to the appended drawings which are given purely by way of non-limiting example and in which:

- Figure 1 is a view in longitudinal section illustrating the various elements constituting an intervertebral linking device according to the invention;

- Figures 2A, 2B and 2C are views analogous to Figure 1 illustrating two steps in the mounting of an intermediate element of the device of Figure 1 in the internal volume of a mobile element of that device; and

- Figures 3A and 3B are views analogous to Figure 1 illustrating the introduction of a fixed element of the device of Figure 1 into the internal volume of the intermediate element.

The linking device illustrated in Figure 1 comprises a pedicular screw 2 which is to be secured in a vertebral body (not shown).

This pedicular screw, which constitutes a fixed element of the linking device, is provided with a rod 3 terminated by a spherical head 4 which comprises an equatorial flat portion 6. The latter extends in an inclined manner to the effect that it is not perpendicular to the principal axis A of the screw 2.

The head 4 is also hollowed out, on the opposite side to the rod 3, with a blind hole 8. The latter is to receive a control device (not shown) which is, for example, the end of a screwdriver or of a hexagonal key.

The linking device of Figure 1 also comprises a mobile element which is illustrated partially and which is generally indicated by the reference 10. This element has a body 12 which extends between the two vertebrae that are to be connected by the device of the invention. This body is terminated by two hollow ends, only one of which, 14, is shown.

Each end defines a housing 16 which constitutes an internal volume of the element 10 and which is bordered by walls 18 forming a portion of a sphere. The transverse dimension $\underline{l}$ of the opening 16' of the housing 16 is smaller than the diameter L of the housing.

Finally, the device of Figure 1 comprises an intermediate element 20 which constitutes a cup. The cup, which has a truncated hemispherical shape, has a thin wall 22 which extends from a base 24 of the cup.

The external surface 26 of the wall 22 delimits a portion of a sphere, the diameter of which is identical to that L of the housing 16. In addition, the internal surface 28 of the wall 22, which forms an internal volume 30 of the cup 20, has a diameter D identical to that of the head 4.

Furthermore, the transverse dimension d of the opening 32 of the internal volume 30 is equal to that of the flat portion 6 of the head 4. The opening is more "narrow" than the internal volume inasmuch as the spherical internal surface 28 extends at an angle of more than 180°.

Finally, the base 24 of the cup 20 is hollowed out with an orifice 34 permitting the passage of a control tool in the direction towards the blind hole 8 of the pedicular screw 2.

It should be noted that the cup 20 is produced from a deformable material, such as polyethylene. This feature, in association with the thinness of the wall 22, enables the cup 20 to be introduced by impaction into the housing 16 of the mobile element 10. The thickness e of the wall 22 is, for example, from 0.5 to 3 mm, preferably from 1 to 1.5 mm.

The mounting of the linking device illustrated in Figure 1 will now be described with reference to Figures 2A, 2B, 2C, 3A and 3B.

First of all, the cup 20 has to be introduced into the internal volume 16 of the mobile element 10.

For that purpose, as shown in Figure 2A, the cup 20 is disposed in such a manner that it is facing the housing 16. Subsequently, it is brought axially closer to the mobile element 10, in accordance with the arrow F.

Given that the cup 20 is resiliently deformable, its transverse dimensions, in particular the inside diameter D of its wall 22, are capable of undergoing a momentary reduction. This therefore enables the cup 20 to be introduced by impaction in accordance with the arrow F into the housing 16 of the mobile element 10 (Figure 2B).

Once that operation has been carried out, as shown in Figure 2C, the external surface 26 of the thin wall 22 extends in contact with the internal surface 18 of the housing 16, having the same diameter. Thus, the cup 20 has three degrees of freedom in rotation relative to the mobile element.

On the other hand it has no degree of freedom in translation relative to the element 10 in this position of use, since the periphery of the opening 16', the transverse dimension of which is smaller than the diameter of the housing 16, prevents the cup 20 from coming out of the housing again.

It is then necessary to introduce the spherical head 4 of the screw 2 into the housing 30 of the cup 20.

For that purpose, the screw 2 is first of all inclined in such a manner that the flat portion 6 extends horizontally in Figure 3A, that is to say, perpendicularly to the principal axis of the cup 20. The cup 20 is then brought closer to the screw 2 in accordance with a translation parallel with the principal axis of the cup 20 (arrow F').

Given that the transverse dimension of the flat portion is equal to that d of the opening 32 of the housing 30, this enables the head 4 to be freely introduced into the housing.

Subsequently, the head 4 is pivoted inside the housing in such a manner that the flat portion 6 is no longer facing the above-mentioned opening 32. In this position of use (Figure 3B), the head 4 is free to pivot relative to the housing 30 but has no degree of freedom in translation relative to the cup 20.

The diameter D of the head 4 is larger than the transverse dimension of the opening 32. In addition, the periphery of the opening 32 is rendered substantially rigid owing to the presence of the rigid walls of the mobile element 10. Thus it is almost impossible for the periphery of the opening 32 to be deformed radially, which prevents the head 4 from coming out of the internal volume 30 again.

Once the device has been placed in the configuration of Figure 3B, it is necessary to fix the pedicular screw 2 in a corresponding vertebral body by means of a control device co-operating with the blind hole 8.

By way of a variation in mounting, it is possible first of all to fix each pedicular screw in a corresponding vertebral body. Then each cup 20 is introduced into a corresponding internal volume 16 of the mobile element, as explained in Figures 2A to 2C.

The fixed element and the mobile element are then brought closer to one another and the cup 20 is caused to tilt within its housing 16. This tilting may be effected by means of a rod (not shown) forming a probe which comes into contact with the base 24 of the cup 20 from the orifice of the housing 16 opposite the pedicular screw 2.

Finally, the intermediate element 20 so tilted is brought closer, relative to each screw 2, so that each flat portion 6 can permit the introduction of a corresponding screw into the internal volume 30.

Once the device of the invention has been placed in the configuration of Figure 3B, it is possible to fit onto the flat portion 6 an advantageously removable stop means, such as a screw 36. The latter, by limiting the pivoting of the head 4 relative to the cup 20, prevents the head from recovering its position in Figure 3, which avoids any inadvertent separation between the cup 20 and the screw 2.

The invention is not limited to the example described and represented.

Thus, the intermediate cup 20 may be received in a housing with which the pedicular screw, and not the mobile element, is equipped. Under those conditions, the mobile element then has a spherical head, similar to the head 4, suitable for being introduced into the internal volume of the intermediate cup.

Furthermore, the screw 2, the mobile element 10 and the intermediate cup 20 are capable of having other arrangements, such as those described in French Patent Application 00 08522, filed on 30 June 2000 by the present Applicant, and also those described in International Patent Application PCT-FR-01/02098, filed on 29 June 2001 by the present Applicant.

The invention enables the objectives mentioned above to be achieved.

The various elements constituting the intervertebral linking device of the invention have a relatively simple structure.

The assembly of these elements is particularly easy for the surgeon because the intermediate element can be introduced by impaction into the internal volume of the mobile element, or of the fixed element.

Then, the presence of the intermediate element permits the mutual mounting of the fixed and mobile elements, even if there is practically no clearance in rotation between those two elements.

Moreover, it should be noted that, even though the intermediate element is deformable, which facilitates the mounting thereof, it becomes substantially rigid once introduced into its housing. This rigidity, which is conferred on it by the rigid walls of the housing, provides satisfactory stability for the device, once implanted.

Thus the device has a high degree of resistance in respect of mechanical stresses exerted, in particular, in traction. In addition, the presence of the intermediate element allows any forces to which the linking device of the invention is subjected to be transmitted only to a very slight extent.